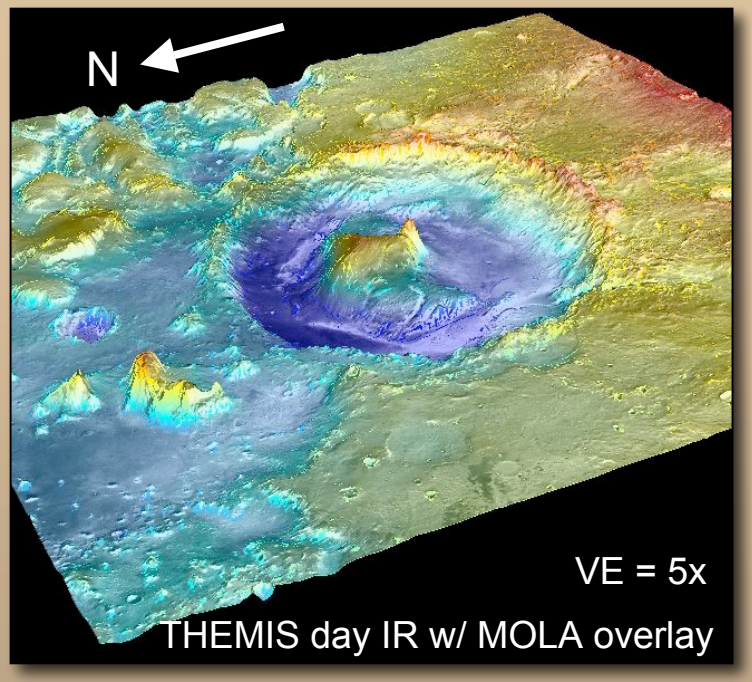
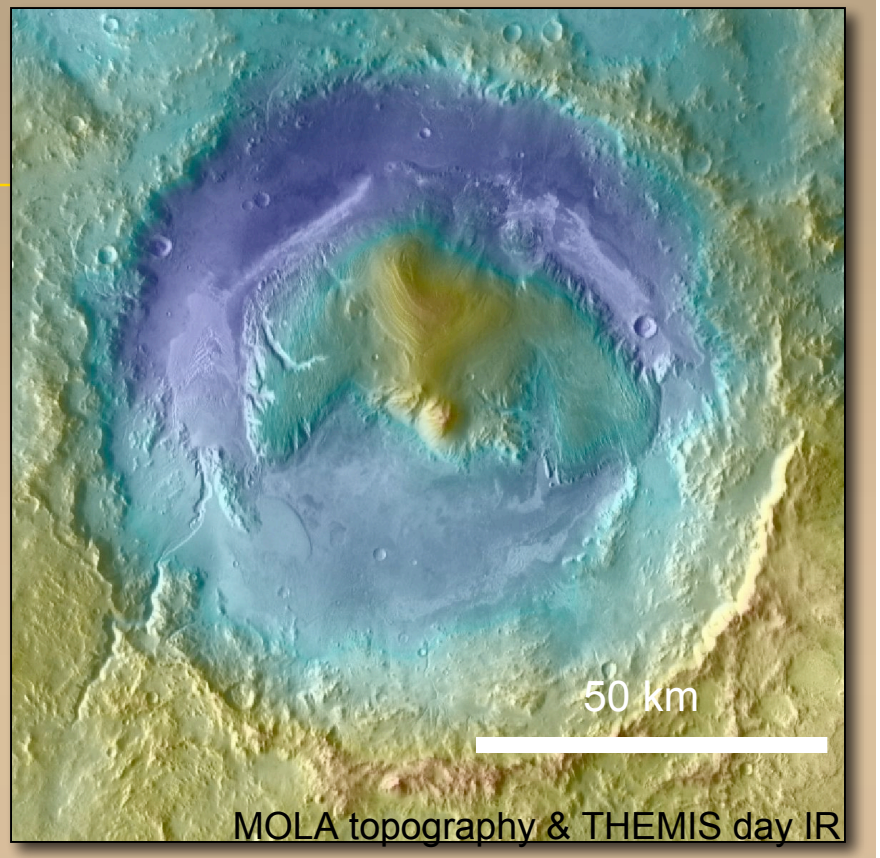
Gale Crater:
Context and layer diversity from HiRISE images



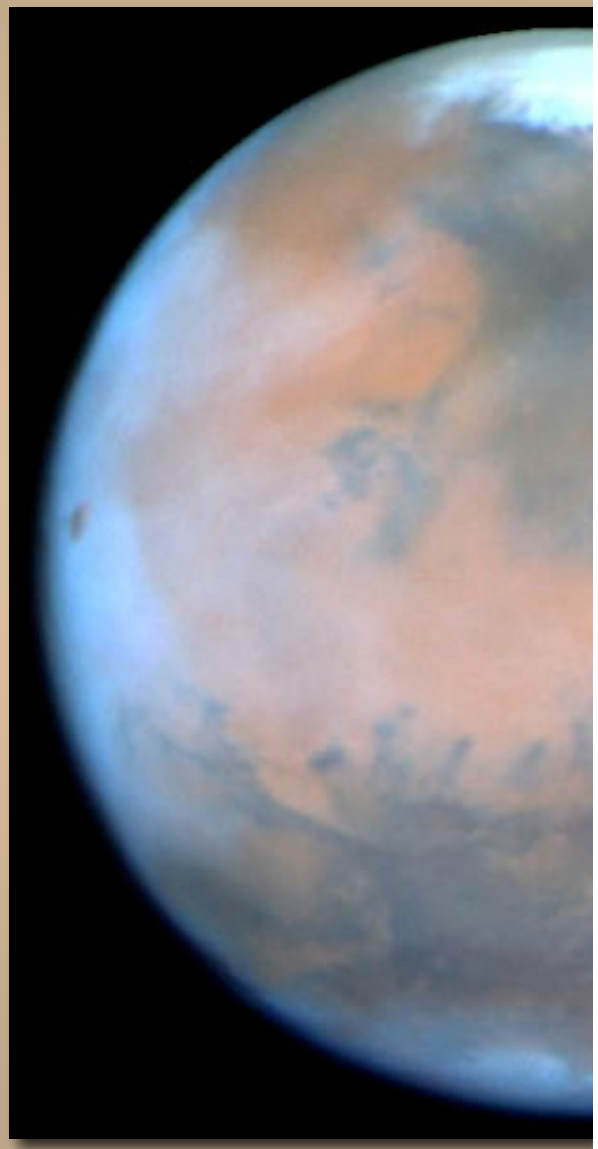


Brad Thomson
Nathan Bridges

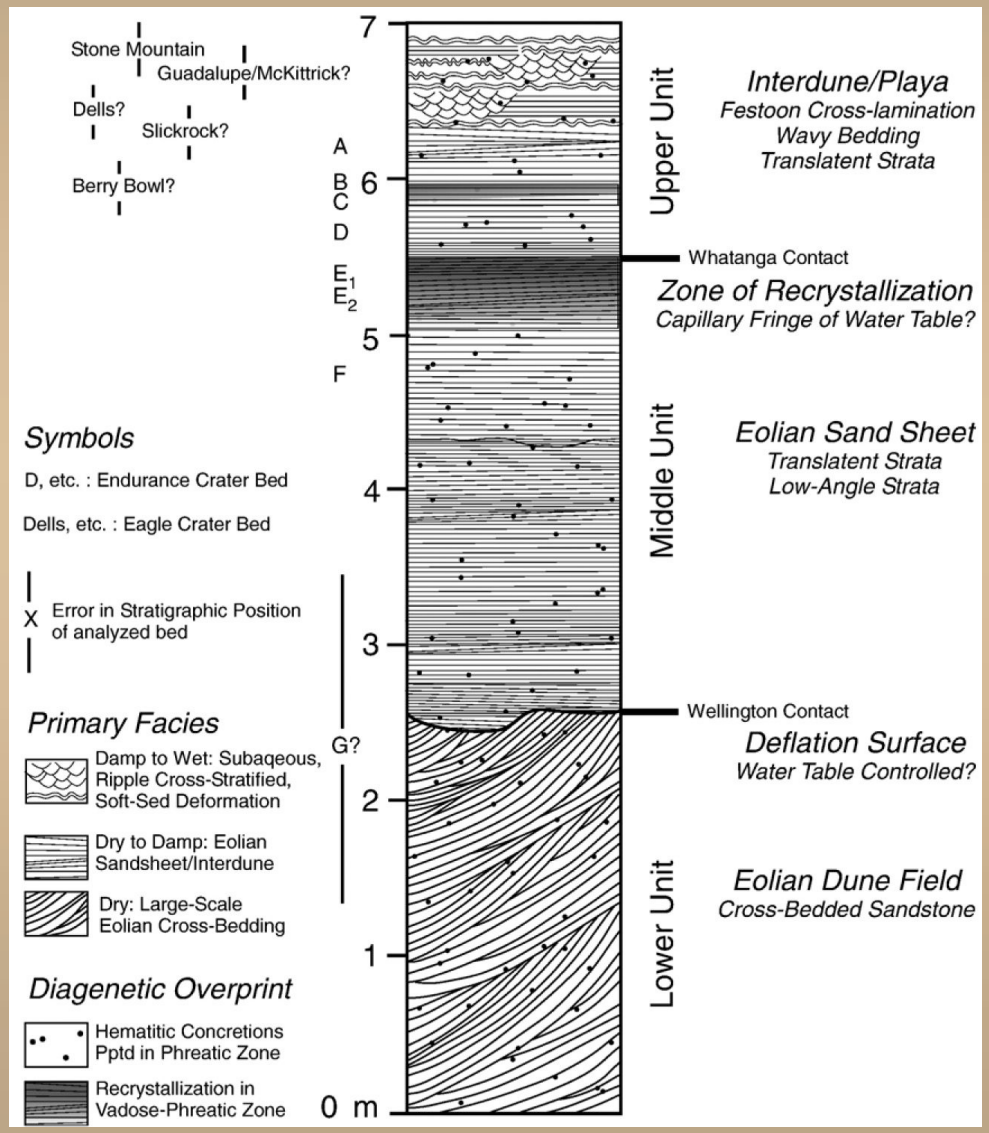
JPL/Caltech

Key Moon-Mars differences

1. Outflow channels
   - VL1, Pathfinder
2. Valley networks
   - Spirit
3. Finely layered sedimentary sequences
   - ~Opportunity, MSL?

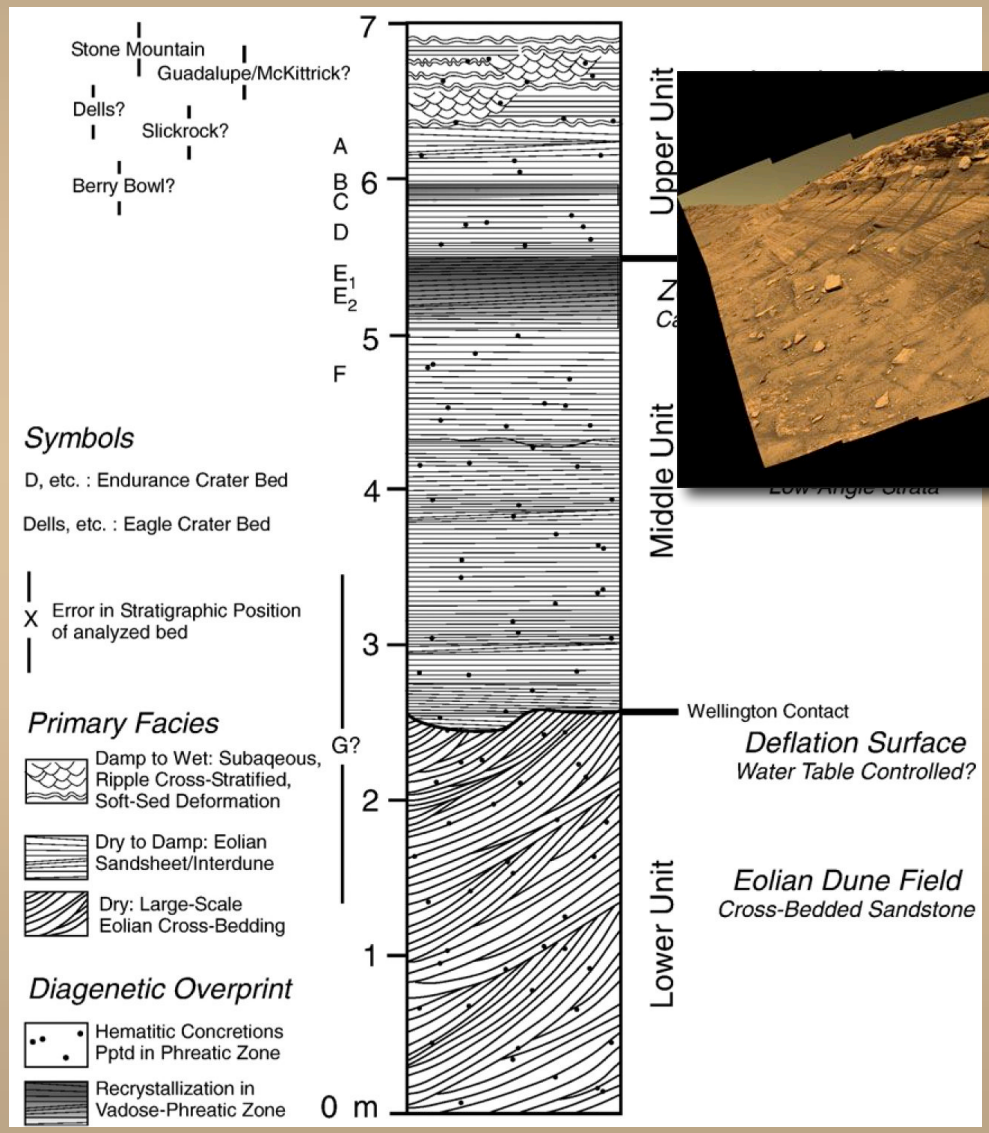


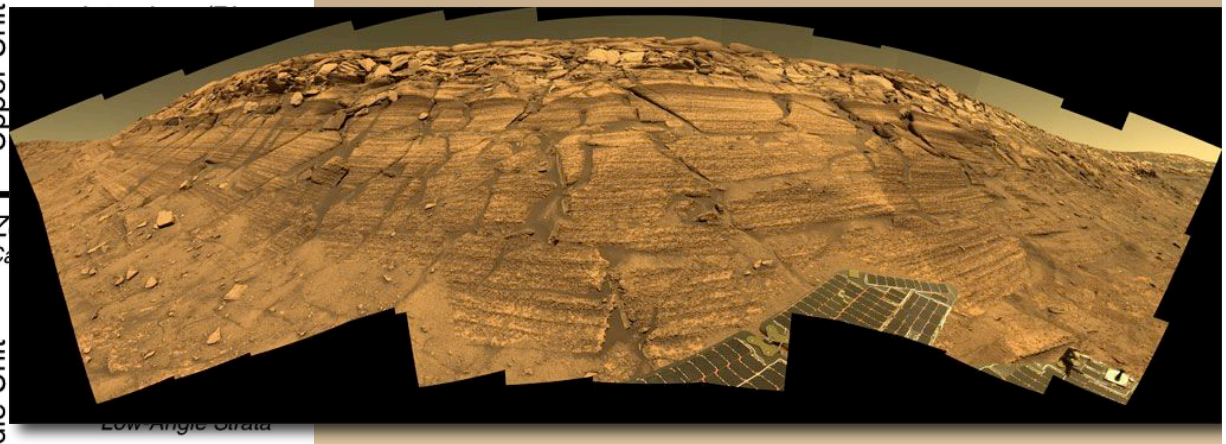
Stratigraphic Framework



Grotzinger et al., 2005

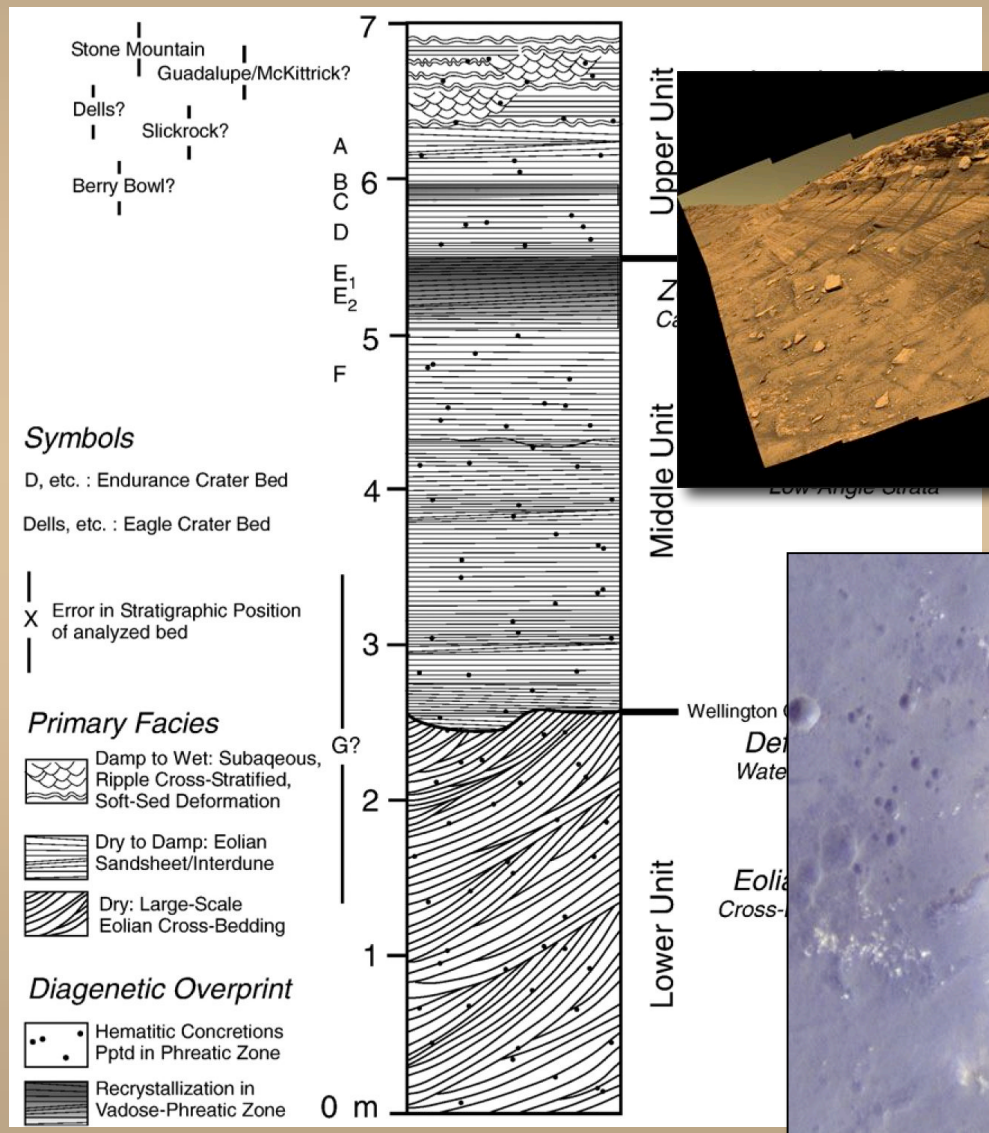
Stratigraphic Framework

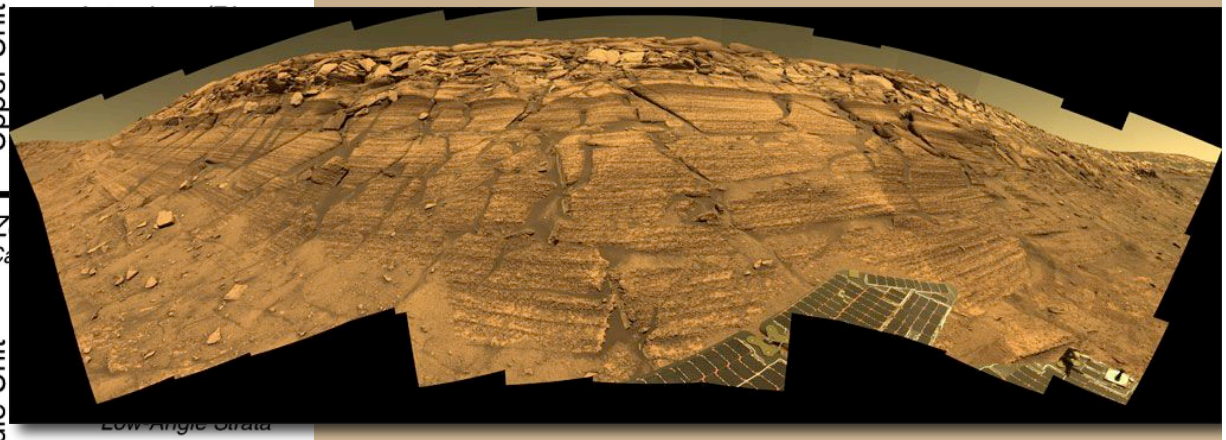


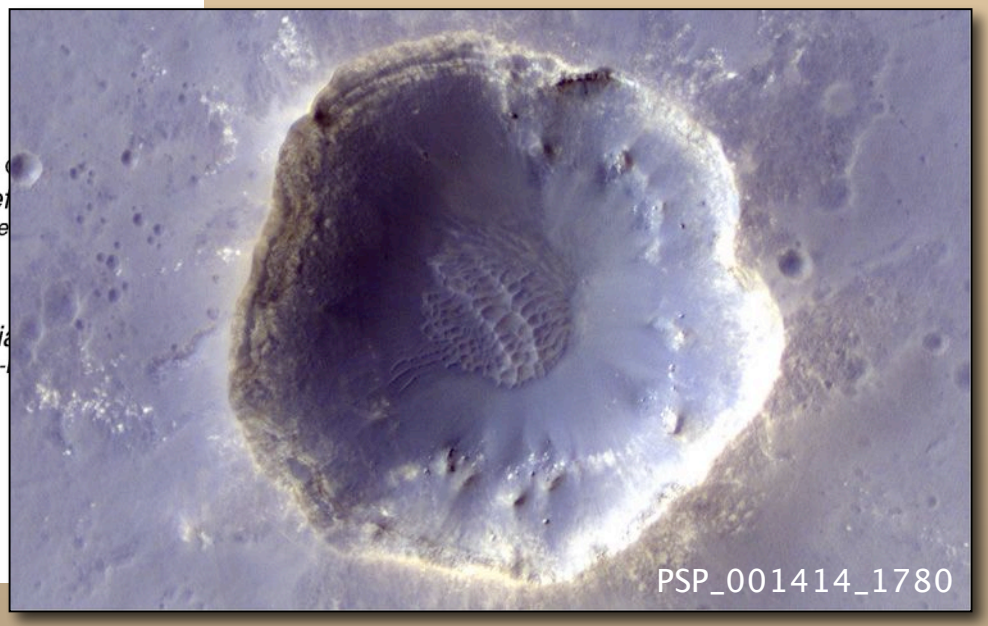


Grotzinger et al., 2005

Stratigraphic Framework

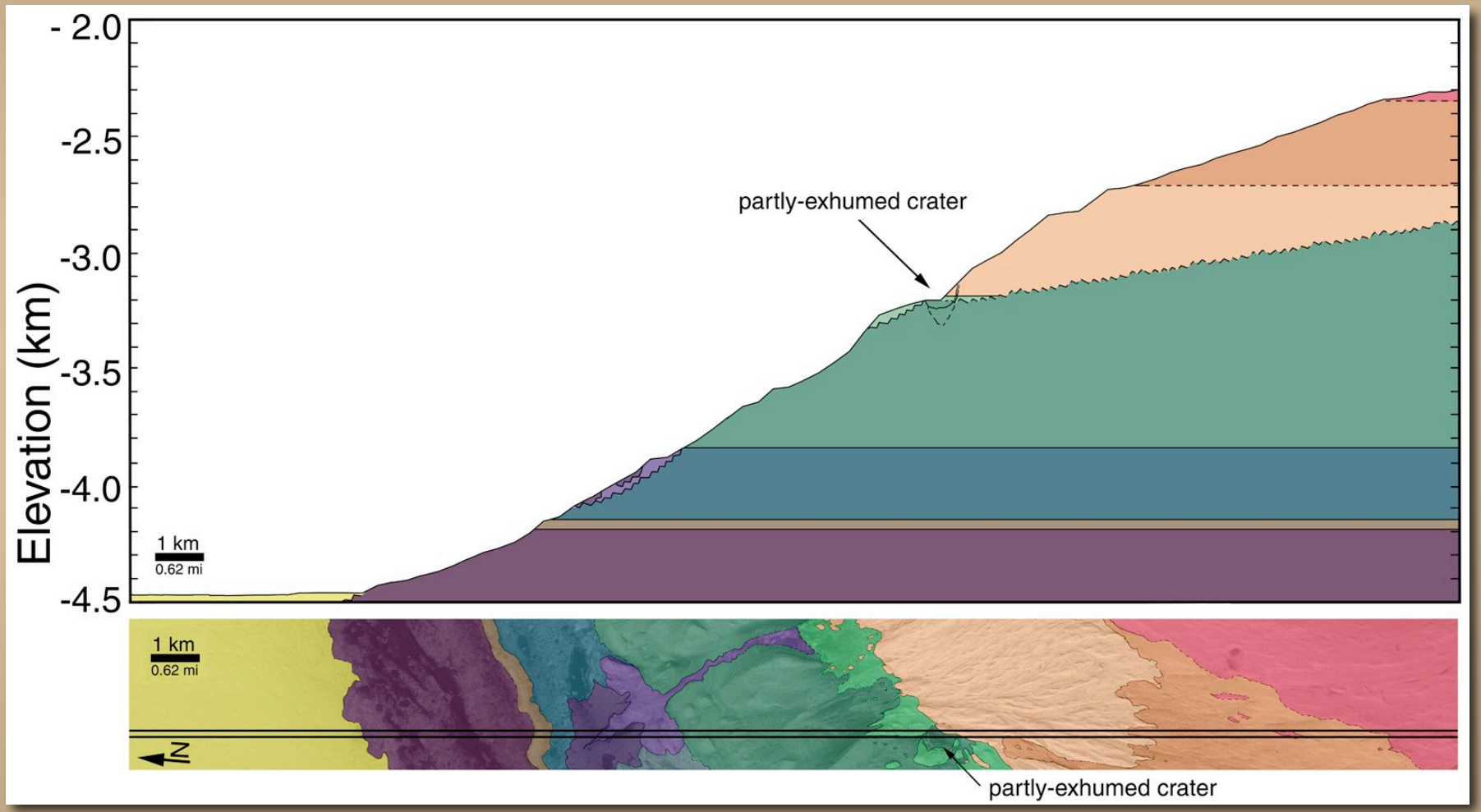






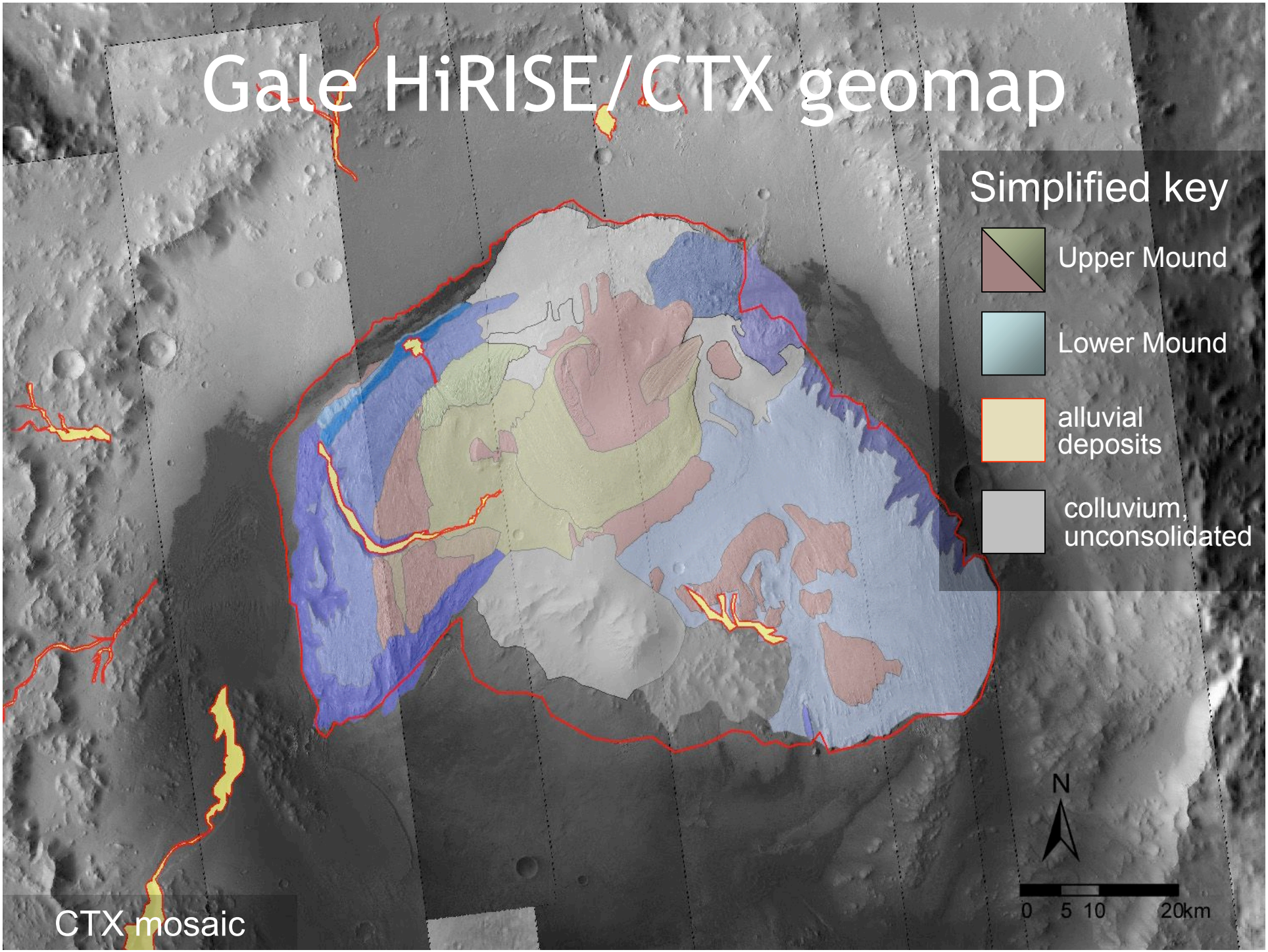
Grotzinger et al., 2005

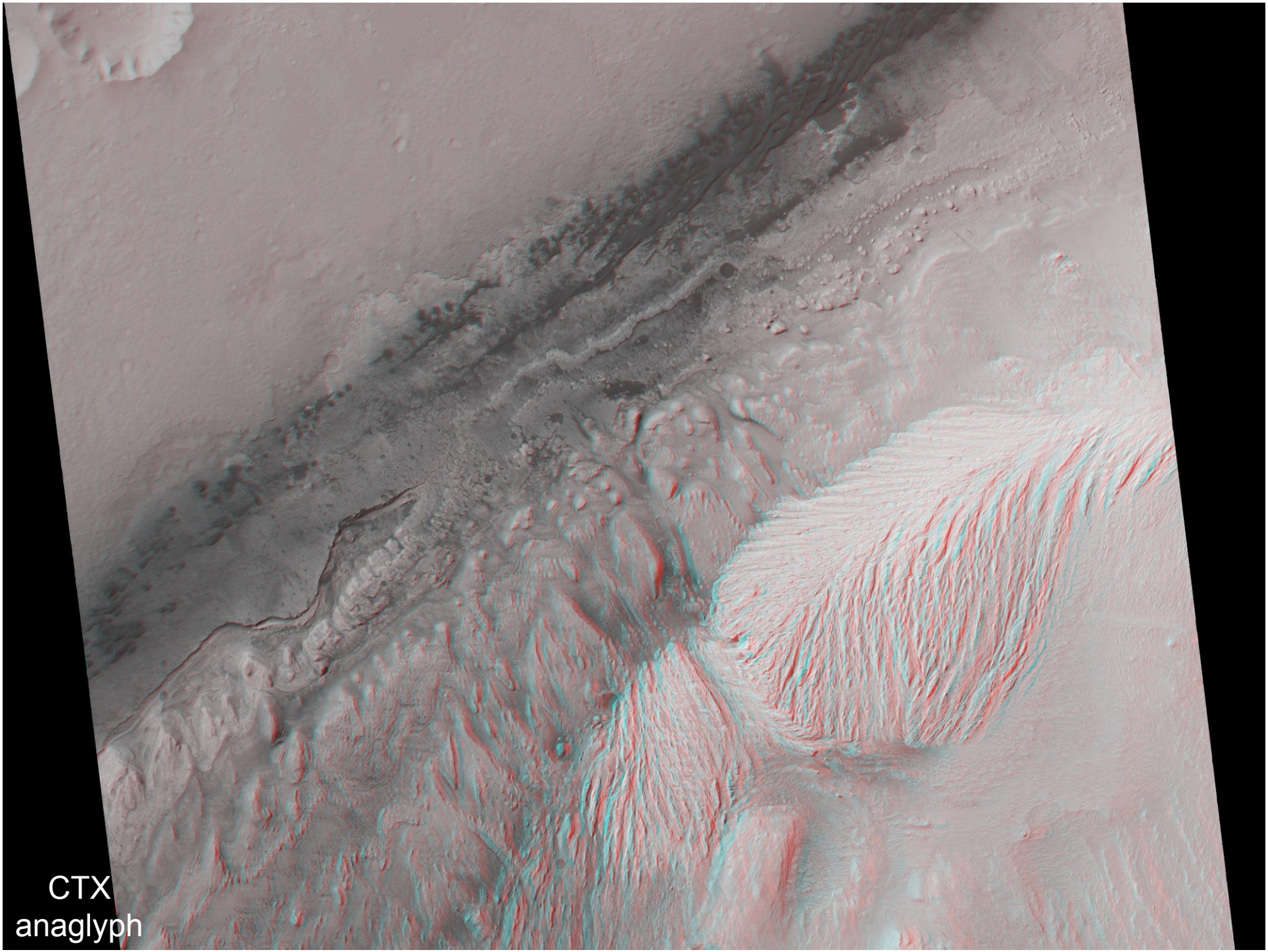
Geologic cross-section



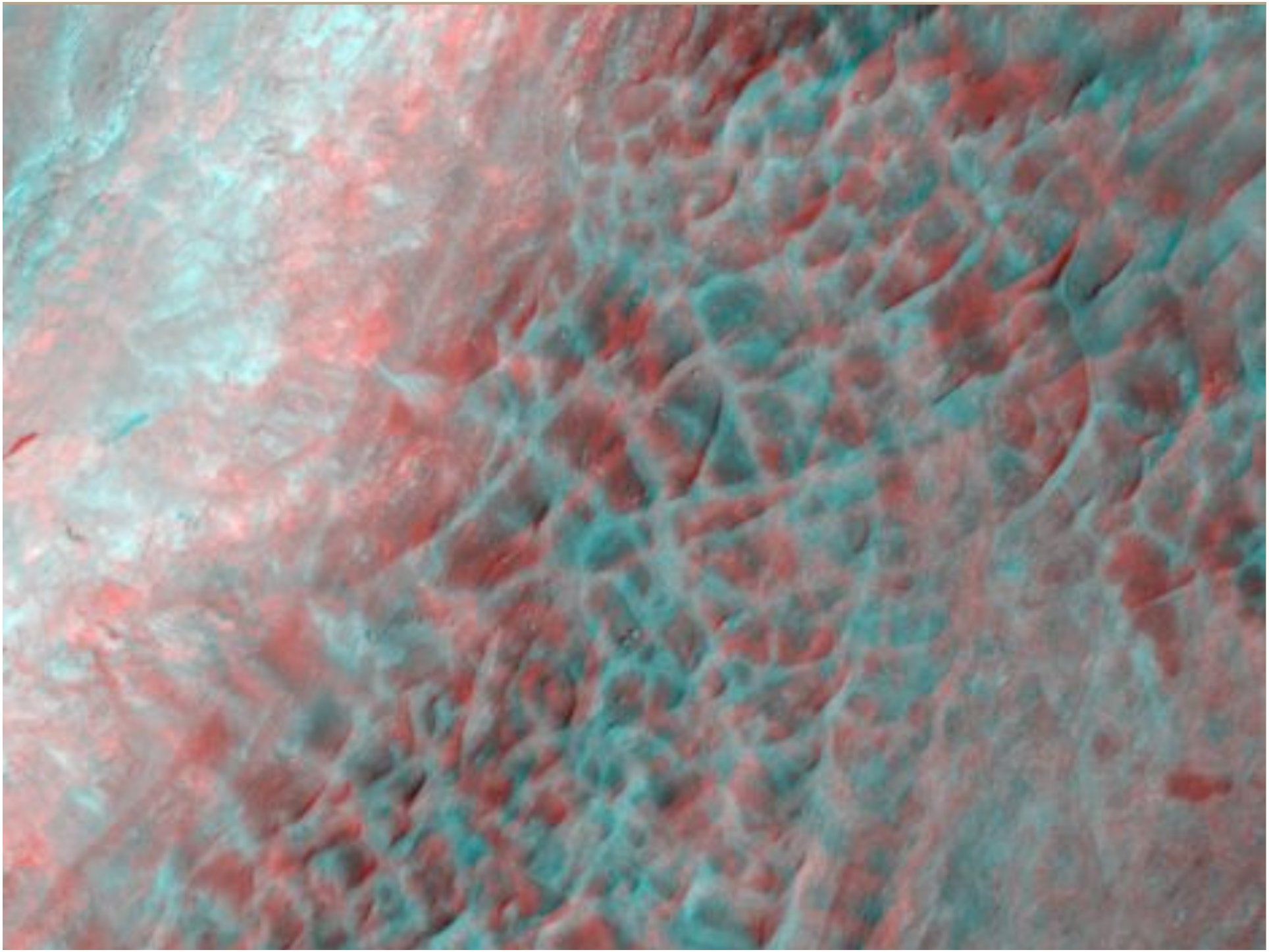
V.E. = 4.7

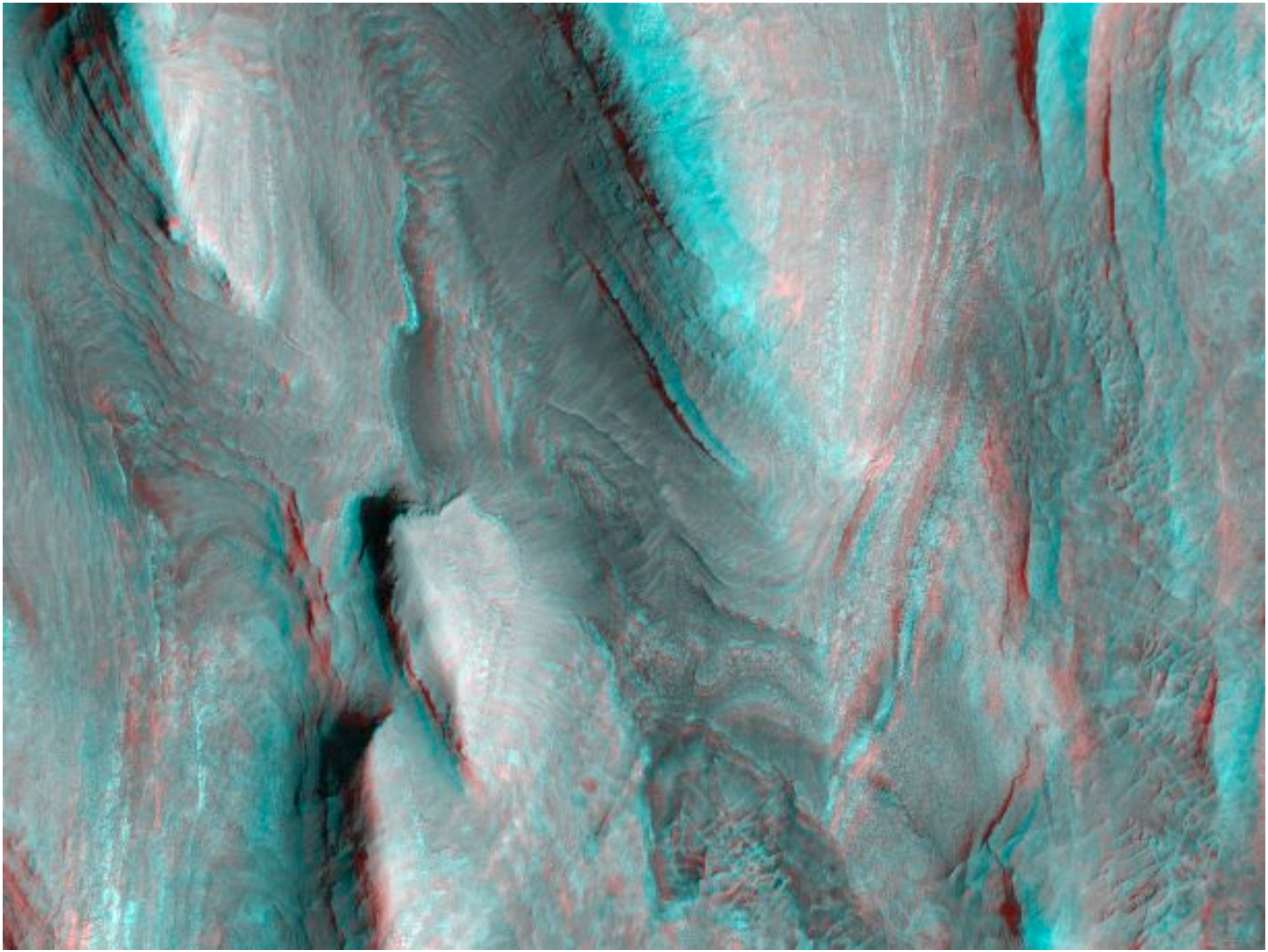
Edgett & Malin, 2000 *LPSC*
Malin & Edgett, 2000 *Science*


Gale HiRISE/CTX geomap
Simplified key
Upper Mound
Lower Mound
alluvial deposits
colluvium, unconsolidated
N
0 5 10 20km
CTX mosaic

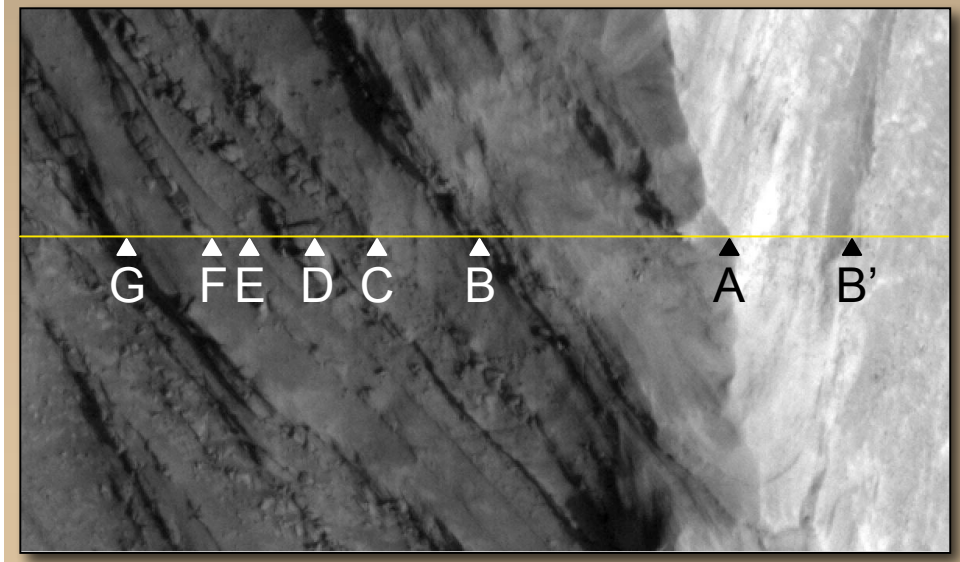

CTX
anaglyph

Lower Mound

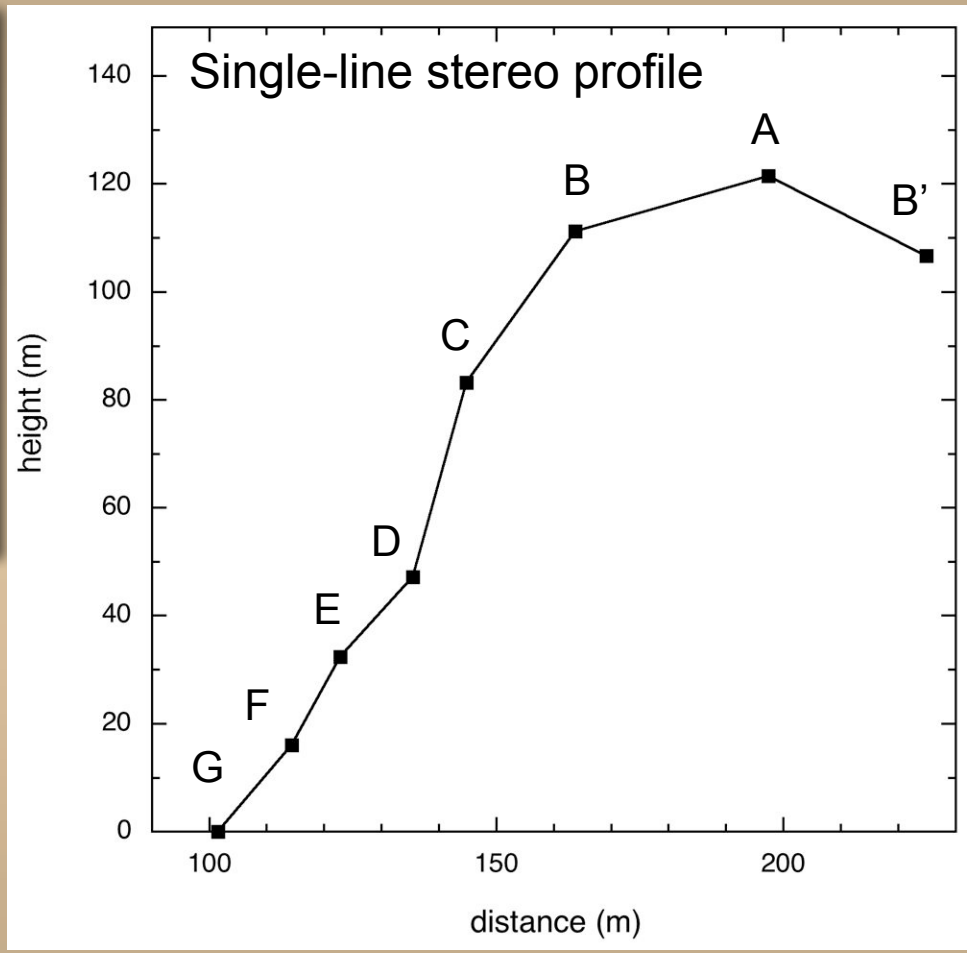




Lower mound layers

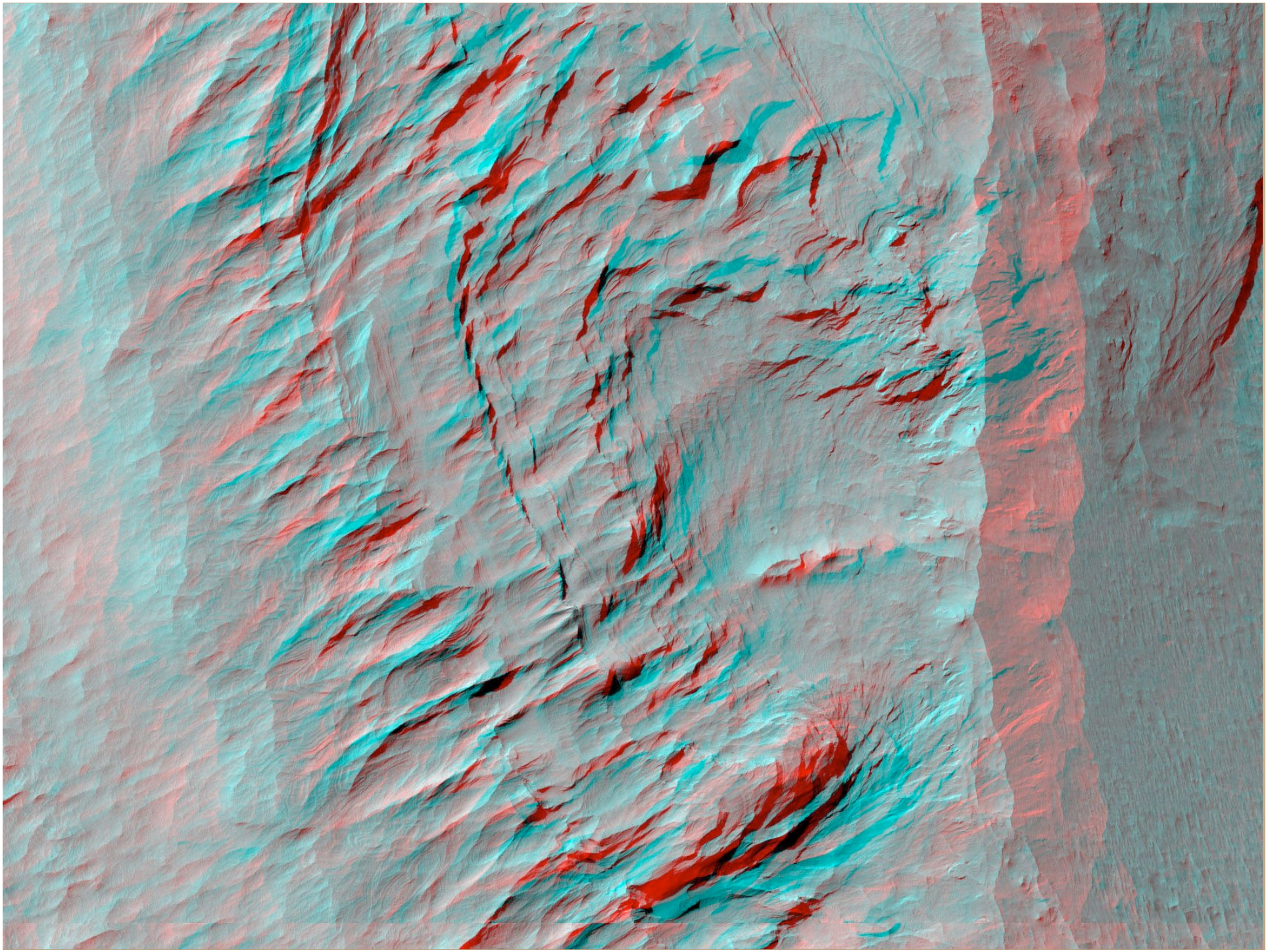


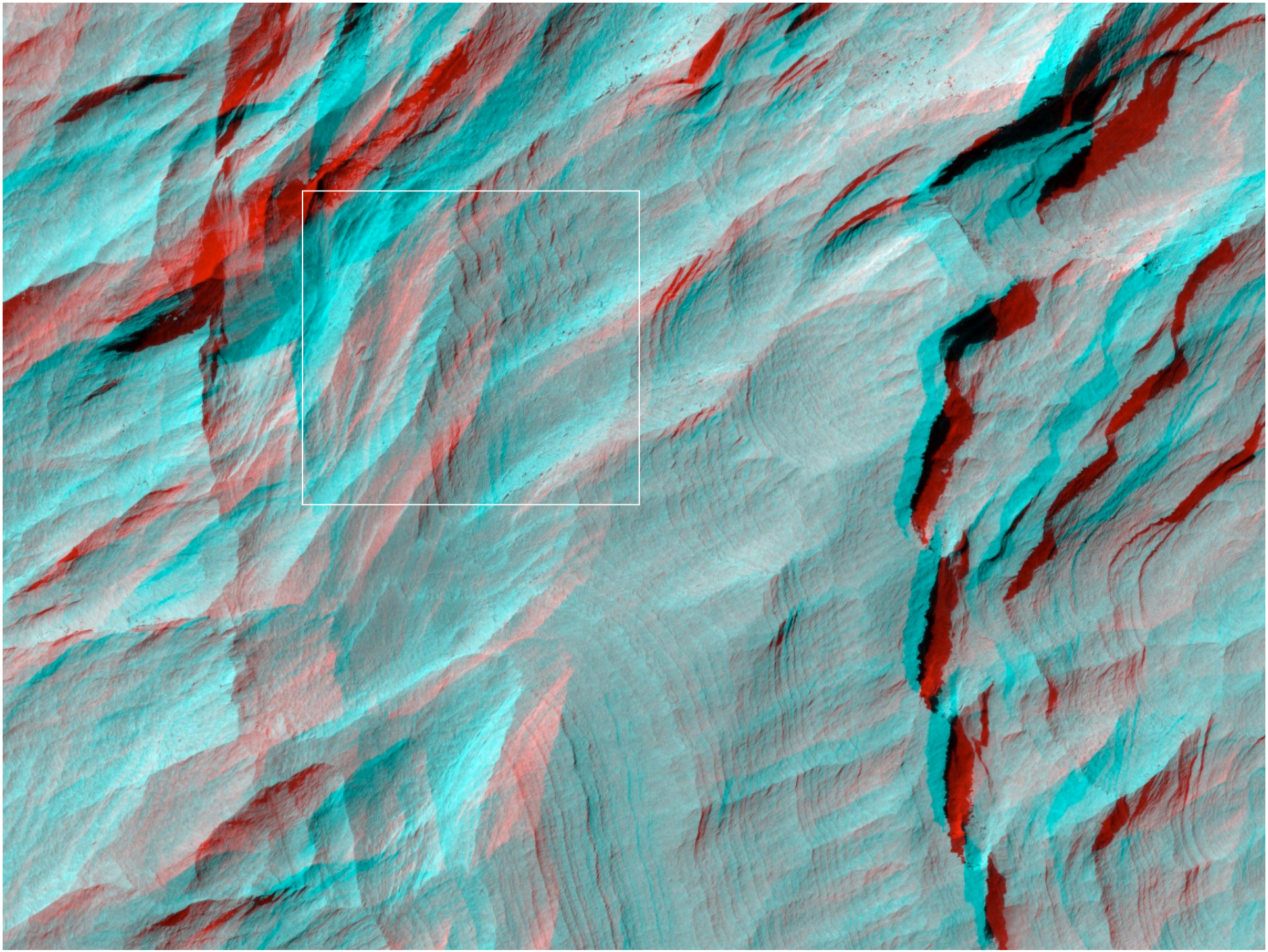
PSP_001488_1750
(& PSP_001752_1750)



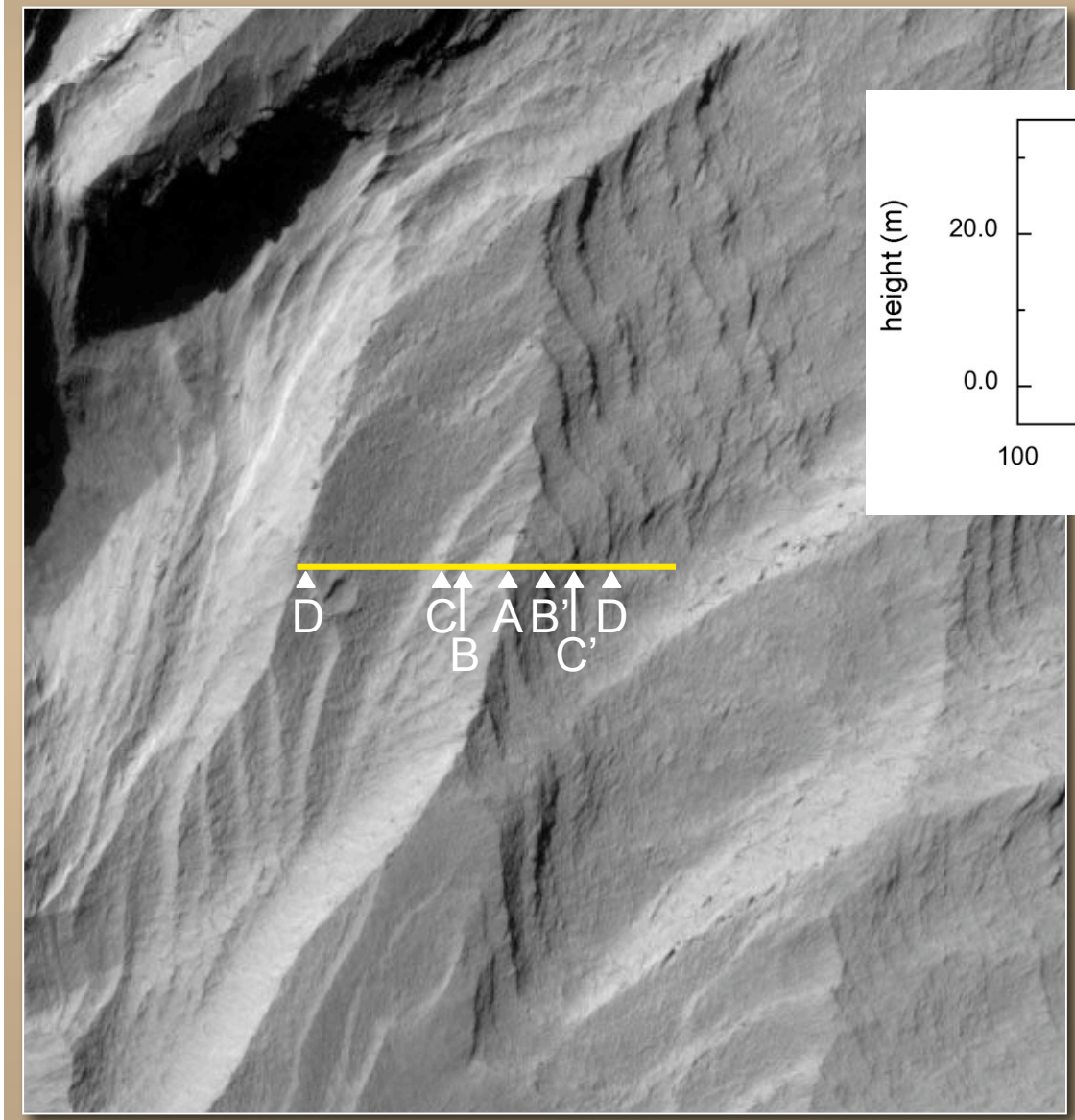
- Layers 10-30 m thick
- Apparent slope ~2°

Upper Mound





Upper mound layers



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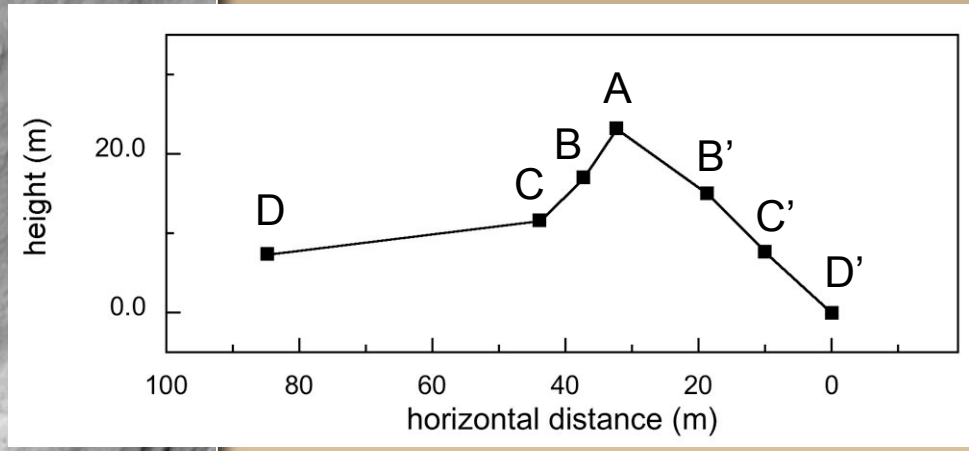
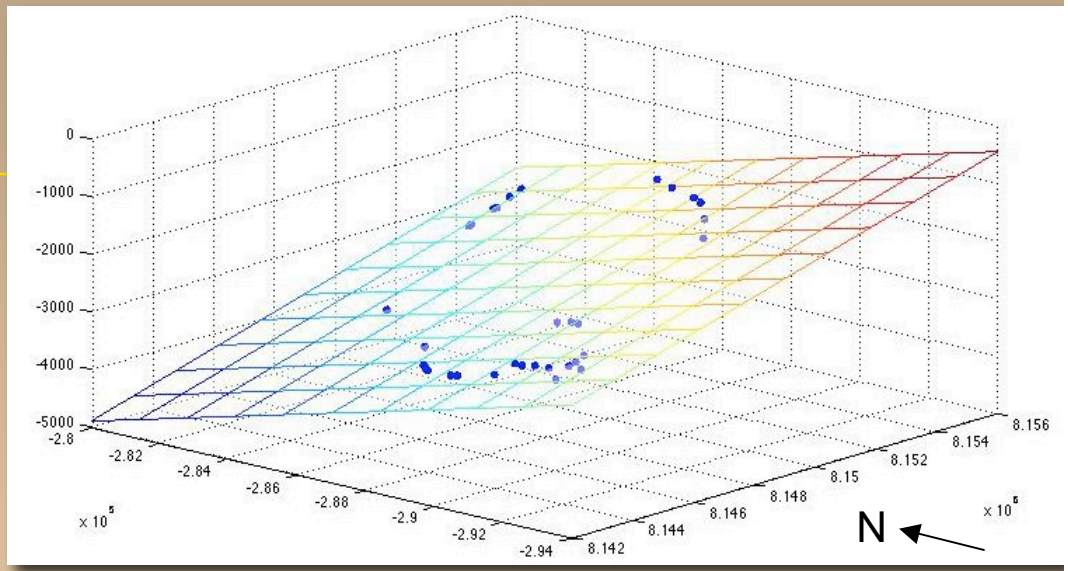
Single-line stereo profile

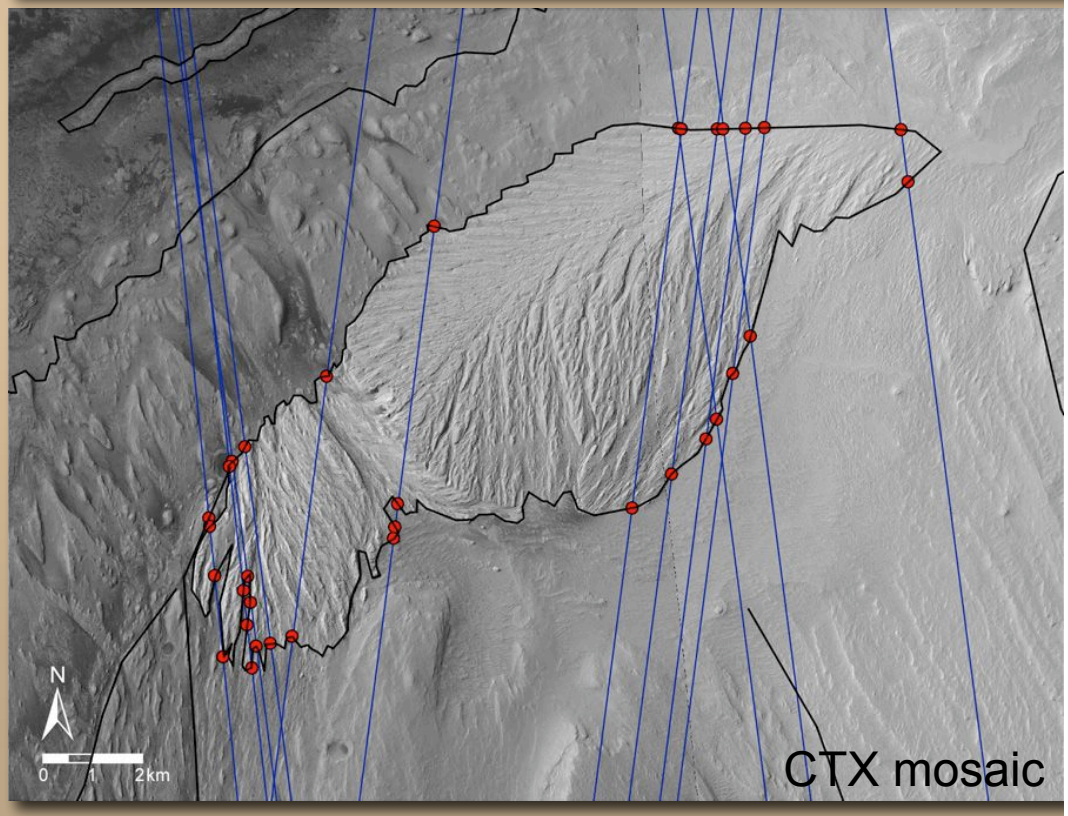


- Layers ~3-7 m thick
- Apparent slopes s_a: $5° > s_a < 10°$
- Dip azimuth is to east (limited to 2D)

Contact geometry

- Mapped upper unit contact (unconformity)
- Extracted MOLA interpolated elevation points along contact
- Best-fit plane is non-horizontal
- Geometry inconsistent with simple lacustrine depositional process
  - Max elevation difference ~1.6 km
  - Suggestive of eolian control of surfaces of omission



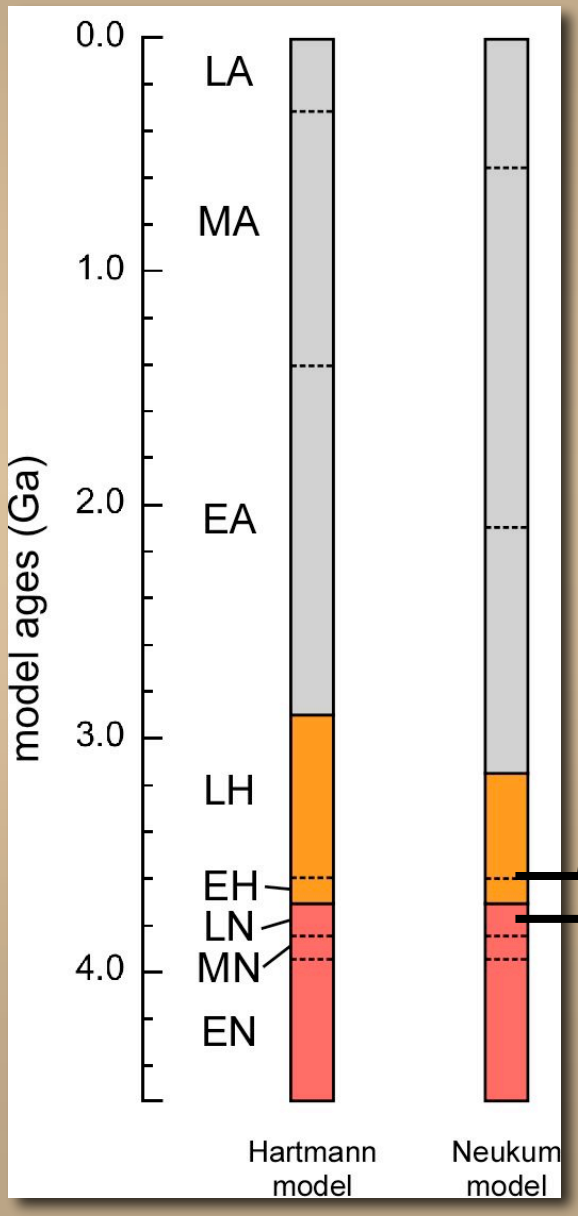


Diversity summary

Lower Mound units have distinct characteristics from Upper Mound, suggesting environmental differences

- Lower Mound:
  - Units with distinct mineralogic signatures that result from aqueous alteration
  - Cemented and inverted fractures suggests fluid flow (potentially indicates some in situ alteration)
- Upper Mound:
  - Erosional morphology, thermal inertia suggests fine-grained component, possibly eolian
  - Attitude of erosional unconformity suggests eolian control of surfaces of omission
  - Channels sourced from Upper Mound suggest additional volatile components

Age context



- Continuing erosion
- Onlapping valley network deposition on crater floor
- Interior channel deposits
- Deposition of upper mound layers
- Depositional hiatus / erosional episode
- Deposition of lower mound layers
- Impact of Gale Crater-forming bolide

Hartman & Neukum, 2001

Overall summary

Context: Low-energy sedimentary depositional environment; general age constraints can also be inferred.

- Closed depositional basin.
- Gale representative of numerous exposures of layered sedimentary units on Mars, non-uniform in space and time
- Long sedimentary record captures environmental changes during deposition.

- Formation mechanism: What can we rule out?
  - **Unlikely:** impact ejecta, effusive volcanism, pedagensis (acting alone), volcaniclastics (lack of regular repetition)
  - **Possible:** lacustrine deposition, eolian deposition

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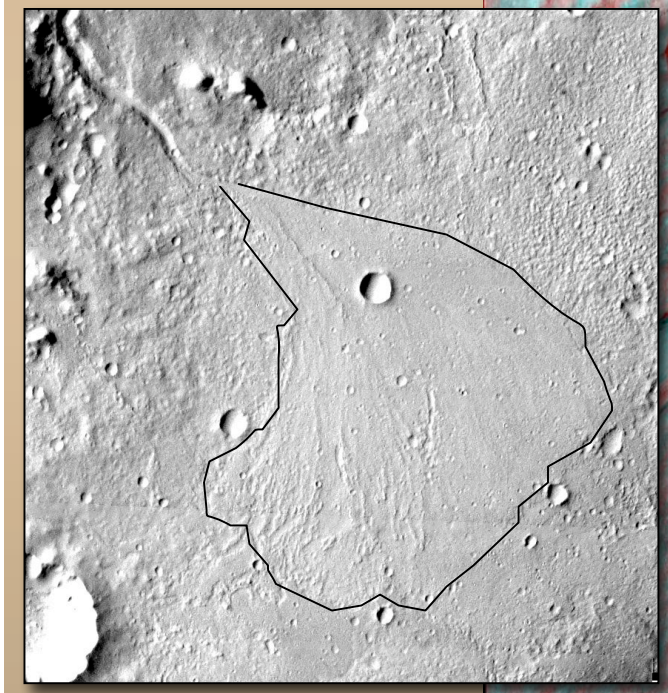
→ Low-energy deposition of particles via settling from suspension in a fluid (wind or water). Even if eolian, aqueous processes played a significant role.

Extra: Ellipse science



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